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Nourishment of the Foetus in Utero

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A  
DISSERTATION

on the  
Nourishment of the Foetus  
in Utero:

With some observations on the effects of Utero Gestation  
on the Maternal system;

And on  
The commencement and effects  
of Respiration

DISSERTATION

ON

Nourishment of the Fetus  
in Utero:

WITH AN ACCOUNT OF THE VESSELS

OF THE PLACENTA

AND

THE MANNER IN WHICH THE

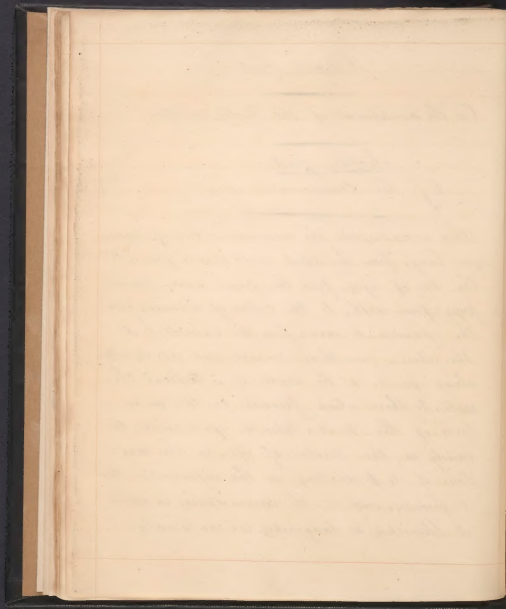
FETUS IS NOURISHED

## Chapter first

On the nourishment of the Foetus in utero

### Section first Of the commencement of life

When we contemplate the numerous orders of organized beings, from the short lived vernal plank to the tree of ages; from the plant which scarcely peeps from earth, to the Cedars of Lebanon; from the ephemera, to man; from the annulets, to the whale; from those animals and plants which almost perish in the winter of a tropical climate, to those which flourish on the mountains of the North: When we reflect on all the variety in the duration of life; in the magnitude of its productions; in the organization that it produces; and in the circumstances in which it flourishes or languishes, we can hardly

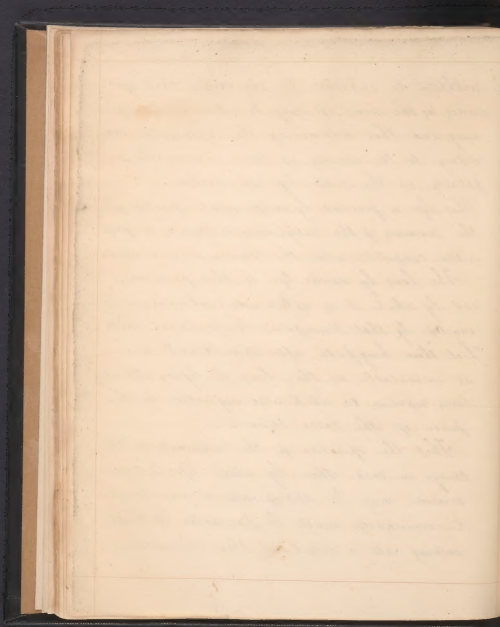


withhold to subscribe to the idea, that life varies as the order of being to which it belongs vary, and that determining the organization according to the variety, it thus secures the perpetuity of the order by reproduction.

That life is produced by an appropriate operation of the rudiments of the embryo on each other, is a proposition compatible with the common sense of man.

The laws by which life is thus produced, and by which it is afterwards continued, being enacted by that Omnipotent Word which said: "Let them bring forth after their kind," are as immutable as the laws of light, attraction, repulsion &c which were originated by the power of the same Word.

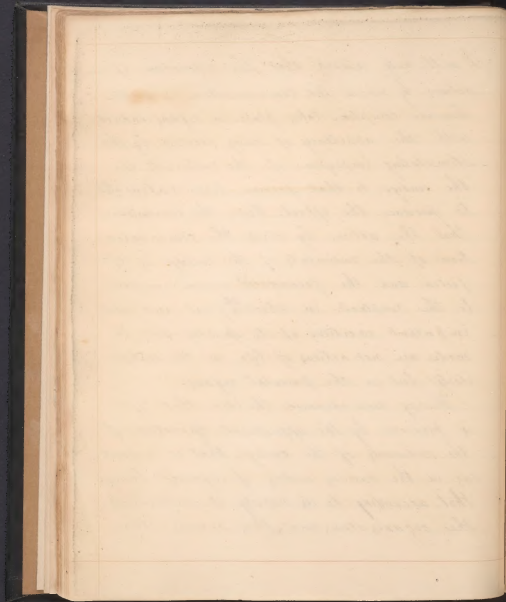
That the operation of the rudiments of the embryo on each other by which life is commenced may be appropriated a variety of circumstances must be favorable. Without entering into a detail of those circumstances





I will only remark that the calculation of actions by which the communication is made, however complex, takes place in organs endowed with the aptitude of being excited by the stimulating impression of the rudiments of the embryo, to that precise train calculated to produce the effect. Hence the conclusion that the actions by which the communication of the rudiments of the embryo is effected and the fecundatio ovum conveyed to the receptacle in which <sup>the</sup> first and most important exertions of its powers may be made, are not actions of life in the embryo itself, but in the parental organs.

Having now advanced the idea that life is produced by the appropriate operation of the rudiments of the embryo; that it is various in the various orders of organized beings; that according to its variety it determines the organization, and thus secures the



perpetuity of the order by reproduction, and that the actions by which life is both sustained and afterwards continued are governed by immutable laws, I proceed to consider the first actions of life in the human embryo.

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### Section second

Of the establishment of a connection and intercourse between the human embryo & Mother.

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Life first manifests itself in the process of organization, and of acquiring those principles necessary for the support of its own actions.

The first actions of life are exerted in the production of an organ through the medium of which, those necessary principles may be acquired. The organ produced for this purpose in the human embryo is the umbilical vein.

The principles to be acquired I will



form the nutritive principles, without having re-  
gard at present to the source whence they  
are originally derived.

Without a supply of the nutritive principles  
vitality cannot continue its action.

The first actions of life are supported  
by the nutritive principles secreted in the  
ovum. In oviparous animals and in the seeds  
of plants, that secretion is considerable.

I must now assume it as a proposition, that  
between the vital and nutritive principles,  
there is a peculiar affinity existing, whereby  
through the medium of the ~~medium of the~~ <sup>umbilical</sup> vein  
even produced for the purpose, which in the  
human embryo is the umbilical vein, a  
supply may be obtained as follows. The  
production of the umbilical vein is  
necessarily attended with some exhaus-  
tion of those principles which supported the  
actions by which it was produced. By



this state of exhaustion the agency of the  
uterus for the nutritive principle is success-  
fully interrupted. The vessels of the  
mother are copiously supplied with the pro-  
perly nourished, whereby the umbilical vein is  
attracted to the vascular surface of the  
placenta or to some other vascular surface (for  
although the cum coagula into the cavity of  
the abdomen it may yet live)

The place where the vessels of the mother  
and embryo come in contact becomes the centre  
of a beautiful train of actions. Whilst  
the vessels of the mother, copiously supplied  
with the nutritive principle, readily unite a  
hostile to the vessels of the embryo, when, under  
the influence of that affinity by which  
it was occasioned, is conveyed. Through the me-  
dium of that vessel to the embryo itself as  
to establish an equilibrium, the neighbouring  
vessels of the mother influence by the





same principle contribute to equilibrium. These  
repeals partially exhausted by the supply  
they have withdrawn; and thus the whole  
material system may be brought to equilibrium.

This connexion and intercourse being  
established the supply must be equal  
to the demand.

The restoration of the circulation in a  
time in which it has been partially  
interrupted by the tying of a minute  
artery, affords a remarkable instance.  
It has great an effect the effects  
between the motive and vital principles  
being in a state of disorder.

Under the influence of attraction there  
is in nature a great tendency to an  
equilibrium. Nature seems to con-  
sist to destroy it, whether repulsion coun-  
ter attraction, condensation or rarefaction.



force, yet the tendency to an equilibrium  
is in all cases manifest. Perhaps there are  
few now of common information who can  
not give a plausible theory of the winds  
and tides. The phenomena of caloric,  
electricity and all the variety of thermo-  
ical affinity are manifested in a ten-  
dency to an equilibrium.

Carbonate of potash absorbs moisture  
from the atmosphere. A bean, an acorn,  
or a muscivore seed will absorb moisture  
from the earth. In either of these cases  
the absorption equally takes place in con-  
sequence of an affinity. If the potash  
were placed under such circumstances that  
all the moisture absorbed would be  
retained it would soon arrive at a  
state of equilibrium with the atmosphere  
and would cease to absorb; but as it  
were by a superior affinity deprived



of its moisture as fast as absorbed, then the equilibrium could not be formed and the absorption would go on, So, if by the process of vegetation the equilibrium were not constantly destroyed the plant would cease to absorb.

That in the human body the action of life may destroy the equilibrium and thus excite or increase the deficiency for those principles calculated to restore it, is not contrary to reason, and, I think, will by observation be proved true. This is the principle hypothesized on which I proceed; but in this limited dissertation I shall not, by any means, be able to show its importance.

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Section third  
Of the distribution of the nutritive  
supply in the embryo.

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Under that attractive influence that we have described as excited by want and as excited to establish an equilibrium, the supply from the mother must tend to that point where the need is greatest. The need must be greatest at the point where the vital action, having commenced, has produced the first exhaustion. The tendency of the nutritive supply being originally towards the principle seat of the sensorium, induces us to believe that these vital action commences.

When the principle seat of the sensorium is supplied, and thereby rendered capable of a farther exertion





of its power, the demand in the lower portion of the embryo preponderates. The medulla spinalis, by attracting the nutritive supply required, causes it to form the aorta, and to descend with itself.

I will here observe, that, I suppose the sensorium endow'd with the means of life manifested in organization, nutrition and growth. Those actions cannot be carried on without a constant consumption of the nutritive principles. This consumption destroys the equilibrium and excites the affinity for a fresh supply.

When affinity exists between two bodies the attraction exerts an equal force on each; but if one be a fluid, it will yield to a force whose impaction would hardly be perceived on a solid. The blood is a fluid which has an affinity for the nutritive principles.



but an affinity inferior to what the  
sensorium has. The blood may be compared  
to a pendulum suspended between a  
positive & negative electric.

Our theory of the distribution of the  
nutritive supply is, that as organization  
progresses, or whenever vital action is  
carried on, the blood in consequence  
of the nutritive principle it contains  
is attracted by the sensorium. By  
pursuing this theory we might trace  
the circulation through its most  
minute ramifications, and show how  
every muscular fiber &c. nourished and  
actuated by its appropriate nerve  
requires and solicits its appropriate artery.  
We will however be content with the  
general position, that on the sensorium  
it is distributed to every part as there  
is demand, and that, as the demand



increases the supply must also increase.

Although the commencement of the circulation may be effected by the affinity of the vital for the nutritive it could in that way be carried on but slowly; the heart therefore must be considered as an auxiliary in carrying on the circulation; but it becomes so powerful an auxiliary, that the primary power is hardly recognized.

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#### Section fourth

#### Of the process of nutrition

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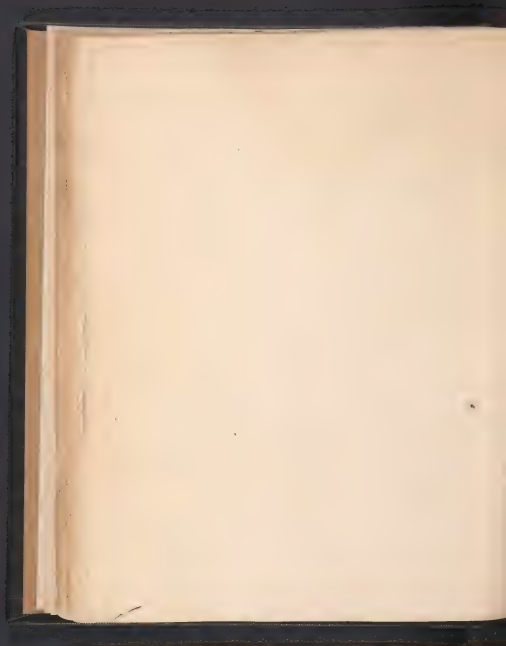
Our method of accounting for the process of nutrition may be at once attributed somewhat peculiar; but we would not say that it is justifiable in admitting to appropriate as



sections more particularly to that subject.  
Vital action, as I have before mentioned,  
is supported by the nutritive principles.  
That action by which the nutritive prin-  
ciples are abstracted from the arterial  
blood is called Secretion. Secretion is  
naturally divided into two classes;  
1<sup>st</sup> the secretion of fluids for the  
support of the system & its various  
actions and parts, and  
2<sup>d</sup> the secretion of fluids excrementitious.

The second class of secretion is  
very inconsiderable in the foetal state;  
for in consequence of the mildness of the  
nourishment afforded the foetus, very little  
excrementitious matter remains, perhaps not  
more in general than may be retained  
as the meconium urine &c.

Blood has an affinity for the nu-  
tritive principles but no affinity for the





than the sensuum has ~~and~~ when deprived  
of those principles to the stronger affinity  
of the 'sensuum' it ceases to be attracted  
for the attraction exists only in consequence  
of the nutritive principle in combination  
with it.

The process of nutrition, considered after  
the nutritive principles are received into  
the circulation, is, according to what is  
above advanced, performed by the sensu-  
-rium, and consists in its abstracting  
those principles from the blood ~~and~~  
and appropriating them to the pur-  
poses of the animal economy.

It is a question of future inquiry, whether  
the blood at the time it yields its  
nutriment, does not also receive from  
the sensuum principles which characterize  
its venous state.

When reflecting on the necessary continuity



of a fluid secreted through the coats  
of the capillary vessels and on the right  
but uniform condensation of it caused by  
the vital actions we cease to view it as a  
subject inexplicably mysterious, the ex-  
istence of animal heat of a uniform  
temperature.

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Section fifth

Of the return of the venous blood

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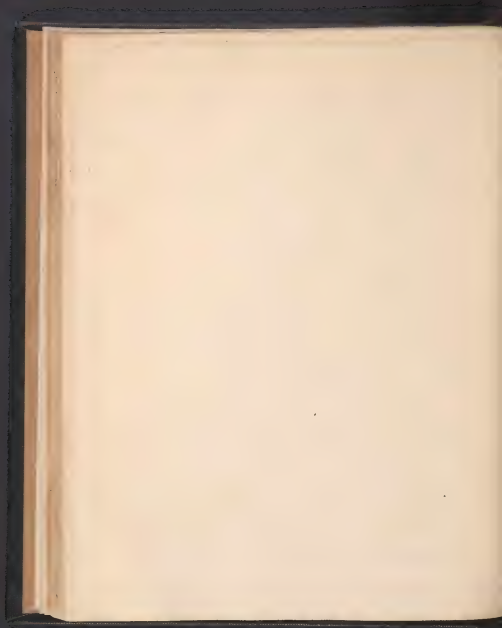
By the influence of the sun's rays the blood  
is rendered venous and in that state is subject  
to an attractive influence very different from  
that of the arterial blood for in consequence  
of its affinity for the nutritive principles  
uninterrupted by any counter attractions,  
(except in some situations gravitation) it  
is attracted towards the greatest and  
most contiguous supply which is in



general the column of arterial blood  
meets the heart.

It is easy to imagine how the nervous force  
under this attractive influence may embrace  
the arterial, but it must be remembered  
that the arterial blood will enervate  
the nutritive principles to the injurious  
demands of the sensuum.

I have compared the blood to a pendulum  
suspended between a body positively and one  
negatively electrified. A pendulum suspended  
between an insulated conductor in which there  
is an accumulation of electricity, and a conductor  
not insulated in which there is no such accumu-  
lation, viz. if within the sphere of their influ-  
ence and range, be attracted to the positive,  
the positive conductor yielding to it a quantity  
of electricity sufficient to establish between them  
an equilibrium. An equilibrium being established  
the attraction ceases, but the equilibrium



between the pendulum and negative conductor being destroyed, the pendulum is attracted to it and to restore the equilibrium imparts its excess of electricity; upon which the attraction ceasing as above; and the pendulum being rendered negative, it is again attracted by the positive, and so on alternately as long as an inequality is kept up. Such is the attraction of the arterial blood by the sensorium and of the venous blood by those principles calculated to render it arterial.

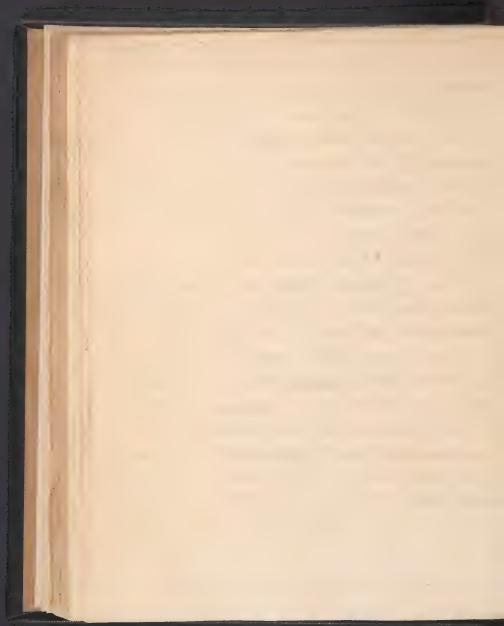
Upon the principle <sup>on which</sup> that I have above accounted for the return of the venous blood, it must in ascending form an arch with the aorta if not directed by some superior attraction consequent upon an attraction in ~~it~~, its qualities. But on meeting with the highly charged arterial blood of the umbilical vein, the attraction being so great as to cause anastomosis, it blends with it, and thus





rendered arterial, is no longer influenced by the arterial blood in the duct, but follows the established course of the supply from the mother. If the attraction were not sufficient to cause anastomosis, the venous blood would upon our principles return the umbilical vein to the placenta.

If a portion of the arterial blood of the fetus (which is less arterial than that in the umbilical veins) arrives in the course of the circulation, (as is the case in the hypogastric artery) at a point where the more highly oxygenated blood passing from the placenta, attracts it with a force superior to that of the descending, but not sufficient to cause anastomosis, it must traverse it to its source, upon the principle of the return of the venous blood.



Section sixth  
Of the placenta

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If an affinity exist between two bodies the power of attraction exerted by each is equal.

Having this circumstance in view it requires no great stretch of imagination to conceive that when the vessels of the placenta are attracted by the nutritive principle in the maternal vessels, the maternal vessels attracted by an equal power, are impelled to grow out and intermingle with the foetal vessels. In this manner I would account for the production of the chorion. Its size bears a proportion to the number of vessels thus intermingled, though it may in some degree be influenced by a more or less copious interstitial densification, and the number of vessels, both foetal and maternal, is proportioned to the supply required.



The advantages arising from the well known structure of the placenta appear very considerable when we consider how great facility this structure affords to the transfer from the maternal to the foetal vessels.

I conceive it possible that an action analogous to double elective affinity may take place in the placenta and that while the nutritive principles pass from the maternal to the foetal, carbon may pass from the foetal to the maternal vessels. If such an action do take place in the placenta the carbon must be in combination with a very subtle fluid; perhaps it may be in the state of carbonous oxide. An enquiry on this subject will become more necessary when I come to speak of the commencement and effects of respiration.

I do not believe that a vessel can be



produced by any other power in the animal economy but the power of organization. The power of organization in such a case as the production of the maternal vessels of the placenta requiring some exciting <sup>cause</sup> ~~force~~ of action. The exciting cause of action I would state to be the attraction as above and the consequent greater determination of arterial blood to that part.

I have now in a diffuse manner said as much as I intended on the nourishment of the foetus in utero.

The limits I have fixed to my dissertation have prevented my introducing that evidence that analogy furnishes in support of the ~~my~~ sentiments I have advanced. In the different orders of organic beings, the power of taking into the circulation and disposing of those principles which





are peculiarly adapted to support the vital action in each, forms a general analogy between orders of the most complicated structure and most simple structures.

The whole process of vegetation evidences an attractive influence. By what other power is the circulation in plants effected? Why, but in consequence of apper attraction arising from a peculiar affinity, do the roots of plants run near the surface in reasonable weather and descend in drouth the tops removed from the light incline to it as if by a voluntary exertion? the pistil & stamen incline to each other as in Collinsionia, and the leaves absorb and give out air? That motion not caused by a propulsive must be caused by an attractive influence; undulatory is sometimes the case! both an attractive & propulsive influence concur to produce the same motions.



Chapter second  
Of the effects of Utero-gestation on the  
maternal system

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Section first  
Preliminary observations

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The particular design of this chapter is to maintain that many of the effects, caused by Utero-gestation, on the maternal system may be rationally referred either directly or indirectly to that abstraction of the nutritive principles which go to the nourishment of the foetus, but which otherwise would have supported the accustomed vital action of the mother.

It is necessary that I should use much brevity, therefore the importance of my position and the extent of its application will but imperfectly appear.



## Section Second

### Of the growth of the Uterus

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The growth of the gravid uterus is the first event or illustration that I will attempt to explain.

The abstraction from the maternal system is made through the medium of the uterus.

The determination to the uterus, by causing an unusual quantity of arterial blood to circulate through the uterine vessels, and to be brought within the sphere of the influence of the uterine nerves, causes in that organ an increased secretion, which, under the influence of the power of organization now aroused to more energetic action, is appropriated to its nourishment and growth.



### Section third

#### Of Constipation, dispepsia and their train

If the demands of the foetus can cause the whole maternal system to contribute to their supply, as stated in the second section of the preceding chapter, then, every part of the mother may be sensibly affected by the privation; thus rendering for, if vital action is supported by the nutritive principles, parts deprived of their usual supply cannot act with their usual vigour.

The determination to the Uterus may diminish the usual determination to the alimentary canal, and thus diminish the usual energy of its action, whereby will be caused dispepsia constipation and their numerous train of consequences, as an accumulation of cruditates on the Stomach.





cardialgia, nausea, vomiting, pain in the head,  
fever and emaciation.

Dispepsia and constipation are the direct  
~~consequences~~ consequences of the diminished action  
of the alimentary canal. These are always in  
a greater or less degree according to the par-  
ticular circumstances of the case. Directly  
resulting from them are, an accumulation  
of crudities on the stomach, Cardialgia, nausea,  
and vomiting. Now these last, may irritate  
the stomach so much as to increase  
the determination to that organ and  
thus excite its healthy action. But if  
they have not this effect then there is  
necessarily a suspension in the usual mode  
of supplying the system with the princi-  
ple of nourishment derived from aliments;  
as the chyle cannot in this case be elaborated.  
If the dispepsia were complete death must  
speedily ensue, unless there were some other



source whence the demand of the system might be supplied, for as vital action is supported by the nutritive principles, if these principles can be no longer acquired vital action must cease. The adipose deposition in the cellular texture is the principle source whence a supply may be obtained by which vital action may in so extreme a case receive temporary support. According to the activity of vital action will be the rapidity with which this source of supply is exhausted. This supply is taken into the circulation by absorption, which, it has now become necessary for me briefly to explain.

In entering upon this explanation I must lay down the proposition, that, between the nutritive principle derived from atmospheric air and that derived from aliment there exists a strong and peculiar affinity analogous to that which influences the return



of the venous blood. In support of the existence of such an affinity much argument might be used. Under its influence the chyle may be so attracted as readily to enter the mouths of the absorbents, and to retrace the arteries, but if the chyle be not elaborated, or not in quantity sufficient to supply the demands of the system, its deficiency in the blood will increase the attraction, and a determination will take place towards the supply deposited in the adipose membrane. In consequence of this determination there will be an unusual evolution of animal heat towards the surface; the fat will be discolored and perhaps receive or give up some principle which alters its mode of existence, and will be made to enter the absorbents <sup>and retrace the arteries</sup> as chyle or venous blood does. Add to this, that blood not duly supplied with the nutritive principle



derived from aliments is an irritant to the  
sensorium and we have the cause of the  
head ache, fever, and emaciation.

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#### Section fourth

#### Of affections of the lower extremities

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The determination to the uterus may in a  
remarkable degree diminish the determination  
to the lower extremities and thus cause  
in them a sense of inaction and deadness  
to a distressing extent, and the descending  
column of arterial blood being insufficient  
to facilitate the return of the venous  
blood, or to carry on an active absorption,  
there ensues the formation of varicose veins,  
and oedematous swellings.

The muscles, in consequence of the privation  
they sustain may be affected with soreness,  
cramps, and perhaps with convulsions.





## Section fifth

### Some general observations

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There is something analogous to a constant  
contraction and struggle between the maternal &  
foetal systems, and if at any time, from violent  
action in the voluntary muscles or from strong  
counter irritation the determination is diverted  
from the uterus, the foetus must suffer  
may perish.

I will conclude this chapter by adverting to what  
I consider a chief cause of pain in the first stage  
of parturition - The contraction of the uterus di-  
minishes the diameter of its vessels, by which the  
circulation is diverted from it, first to the lower extremities.  
The increased quantity of fluid thus made suddenly  
to pass in the arteries going to the lower extremities I  
believe to cause much pain, partly by distension  
and partly by the unusual quantity of arterial blood  
supplied to the sensorium about the loins & hips especially.



### Chapter third Of the commencement and effects of respiration

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#### Section first Of the commencement of respiration

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By the contraction of the <sup>in parturition</sup> uterus, the nutritive supply from the mother to the foetus is gradually diminished whereby the whole portal system, but particularly the organs of respiration are operated in the same manner that they are subsequently liable to be by suffocation.

This at length amounts to convulsions. A convulsive contraction of the inspiratory muscles enlarges the cavity of the Thorax, which, upon a well known principle, causes the first inspiration.

When the convulsive contraction has subsided expiration might be caused by the elasticity



of the parts returning them to their usual situation, but it is aided by a convulsive action of the abdominal muscles, whereby is produced violent expiration attended with sneezing, coughing, crying &c.

If there be an obstruction to prevent the air flowing into the lungs when the muscles act, then, but little perceptible effect can be produced, for the strength of the muscles is not sufficient to overcome atmospheric pressure, and make in the thorax a vacuum. A tremulous motion might probably be observed.

Having, now, briefly explained the commencement of respiration, I proceed to the consideration of its effects, and I will commence with

### Section Second

The change in the circulation at birth

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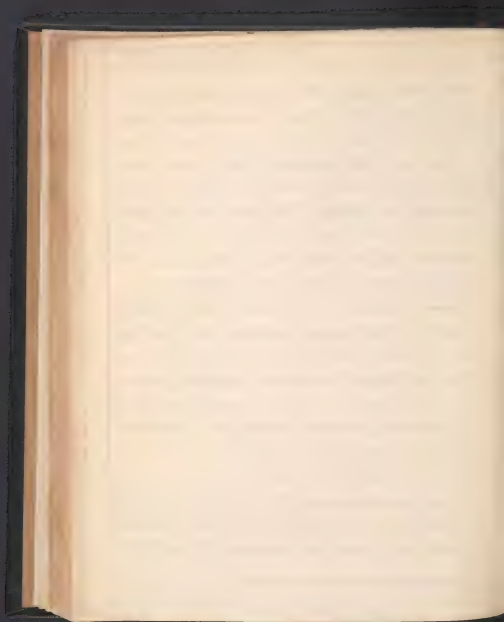
Anterior to birth the nutritive principles



were derived from the mother in a state of intimate combination. It was therefore unnecessary when treating of the foetal nourishment to point out the sources whence those principles were originally derived. It has now become necessary in treating this part of my subject that I should explicitly mention, that, that principle which peculiarly characterizes arterial blood is derived from atmospheric air.

I have explained, how under the influence of the attraction of arterial blood, the venous blood might be made to retrace the arteries. I have also explained, how under the influence of an analogous attraction the nutritive principles derived from aliments might be taken into the system, and other cases of absorption carried on.

If we can conceive that arterial blood is capable of exercising such an influence we can also readily conceive, that, that





principle which renders it arterial is  
capable of exercising an analogous influence.  
I therefore proceed upon the idea, that  
atmospheric air is capable of attracting  
venous blood.

As an evidence of the <sup>existence</sup> of such an attrac-  
-tion I would introduce the circumstance  
of the determination to the surface  
in cases of suffocation, or even in  
voluntary suspension of respiration.

As soon as respiration commences,  
the venous blood, attracted by the air  
diffused through the air cells of the  
lungs, sustains to those organs a copious  
determination which taking off the  
purple through the foramen ovale  
and ductus arteriosus allows them  
to close gradually.

When the blood has undergone that  
change and received that principle



by which it is rendered arterial it  
retraces the venous blood to the heart.  
How the arterial and venous blood  
may here influence each other may  
be understood from what I have before  
advanced.

It must not be denied that the blood  
in the left auricle and in the aorta  
in some degree counterbalances the blood  
in the right auricle and in the pulmon-  
ary artery and options some resistance to  
its flowing freely through the pulmonary  
artery and ductus arterialis. But when  
we reflect upon all the mechanical  
aid that can in this case be afforded  
we find it incompetent to account  
for the effect produced. I therefore  
conclude by observing that the blood is  
determined to these lungs by its attraction  
for a certain principle in the air dif-



pass through the air cells.

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Section third.

Of the decarbonization of the blood

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In speaking of the placenta, I sometimes mention the possibility of an action on that organ analogous to double elective affinity; I come now to speak of an action in the pulmonary organs that I suppose similar.

The production of carbonic acid gas in respiration is an important physiological fact. What gives the carbon in this case is pure oxygen for oxygen that, at a temperature of animal heat the coils of the vessels interfering, will not prevent its combining with it is the first question that excites my curiosity; my curiosity is the more excited when I reflect that the carbon is taken from a fluid incombustible

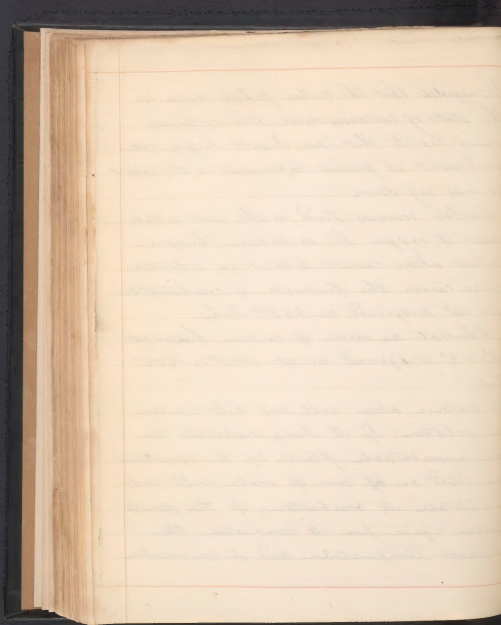


I suggested that the carbon perhaps existed in the states of carbonous oxide. The reflections which led to that idea I will briefly state as I cannot at present experiment on the subject as was my desire.

Carbon remaining fixed in the most intense heat if oxygen be excluded; therefore caloric alone cannot hold it in solution. Pure carbon, the diamond, is combustible at  $14^{\circ}$  Wedgewood or  $2897^{\circ}$  Fahr.

Charcoal an oxide of carbon burns at  $1^{\circ}$  or  $2^{\circ}$  Wedgewood or at  $1000^{\circ}$  or  $1500^{\circ}$  Fahr.

If caloric alone will not hold carbon in solution; If its being suspended in an incombustible fluid of the consistency of blood or ~~of~~ even of water will not facilitate its combustion; if the purest carbon require for its combustion the highest temperature; and if combination





a portion of  
with oxygen under more easy the combina-  
tion with an additional portion; then I  
infer that the combustion of pure carbon  
does not take place in the lungs, but  
that the carbon is combined with the  
greatest portion of oxygen below saturation.

This must remain a subject for future investigation.  
To suppose, in the foetus, the carbonous oxide to be  
elaborated by the action of the sensorium on the  
nativive supply, and to be taken up by the blood at  
the time it parts with its nativive principles to the  
sensorium; to suppose a similar exchange again to  
take place in the placenta between the maternal  
and foetal vessels; and again, an exchange not much  
dissimilar, to take place in the lungs of the mother  
in which the carbonous oxide (perhaps positively  
electricity) unites with an additional portion  
of oxygen and is expired, would not seem  
wholly irrational.

S. S. Jones

Rev

M. = ~~Jefferson~~